



Troubles and Countermeasures of Earthquake Disasters prevention and

Mitigation in Villages and Towns of China

Deng Xue-song, Zhang Chao and Zhou Yun

School of Civil Engineering, Guangzhou University, Guangzhou, China 510006

Email: deng2593@163.com

ABSTRACT: Based on the field investigations of the 26 November 2005 Jiujiang earthquake in Jiangxi province, the 22 July 2006 Yanjin earthquake and the 3 June 2007 Pu'er earthquake in Yunnan province, it is concluded that some new and unexpected important lessons should be noted from the responses of structures under earthquake actions, while with the examinations of seismic damage in villages and towns. According to the goal of earthquake prevention and disaster mitigation in 2020, the present capability and situation of earthquake prevention and disaster mitigation in villages and towns of China are analyzed, and some troubles, which contain earthquake fortification, disaster reduction system, infrastructure construction and so on, are pointed out. Finally, some corresponding countermeasures and suggestions are proposed, so as to improve the capability of earthquake disaster reduction in villages and towns of China.

KEYWORDS: Villages and Towns of China, troubles of earthquake prevention and disaster mitigation, countermeasure

1. INTRODUCTION

China is one of the countries that have the most intensive mainland seismic activity in the world. According to some pertinent statistical data [1], there are 19 earthquakes of M 5 and 4 earthquakes of M 6 occurred in our country land every year, and 2 earthquakes of M 7 every three years. However, in recent years, with the development of social economy and the progresses of science and technology, some remarkable achievements in the construction of earthquake prevention and disaster mitigation have been obtained in our country [2, 3]. Such as the system of national earthquake prevention and disaster mitigation has been gradually completed, many large and medium-sized cities have gotten some bigger enhancements to the capability of earthquake disaster defense. However, because of historical and realistic factors, such as economic level, political policy and so on, the focus of the national construction were always put in the cities, while the countryside development was not taken into account. However, many earthquake disaster investigations showed that, within the same seismic intensity zone, the proportion of casualties and building destruction in villages and towns was far higher than that in cities. That is because in these impoverished regions, on the one hand, the weak economic basis limited the greater development of local earthquake prevention and disaster mitigation construction. On the other hand, the inadequate earthquake-resistance ability conversely resulted in “small earthquake caused heavy disaster” and “every earthquake caused disaster”, which seriously hindered the development of local economy. Faced with such a vicious circle, how do the villages and towns of China get out of the plight of earthquake prevention and disaster reduction? This is not only related to people's livelihood and social stability, but also an inevitable requirement of solving the “Agriculture, Countryside and Peasant” issues and achieving a grand goal of building a moderately prosperous society in all respects. According to the earthquake damage in villages and towns in recent years, the capability and situation of earthquake prevention and disaster mitigation are analyzed, some relevant countermeasures and suggestions of strengthening capacity construction are proposed, which are hoped to provide some helps for our country's development of earthquake prevention and disaster mitigation in

villages and towns.

2. SEISMIC DAMAGES OF VILLAGES AND TOWNS IN RECENT EARTHQUAKES

According to statistics, there have been about 250 earthquakes of $M_s \geq 5$ occurred in mainland of China since 1996, of which about 127 earthquakes caused disaster. Meanwhile, the overwhelming majority of the hazardous earthquakes occurred in the western areas with underdeveloped economy, such as Yunnan, Xinjiang, Sichuan, Tibet and Gansu, etc. Especially in 2003, there were 21 earthquake disasters occurred in mainland of China in the whole year, with their epicenters all falling into the villages and towns. Actually, since 2001, there are about 11 destructive earthquakes with heavy disaster came about in China. Among them, the author's research team conducted the field investigations to 2005 earthquake in Jiangxi Jiujiang, 2006 earthquake in Yunnan Yanjin and 2007 earthquake in Yunnan Pu'er [4-8], as shown in Fig. 1-3.

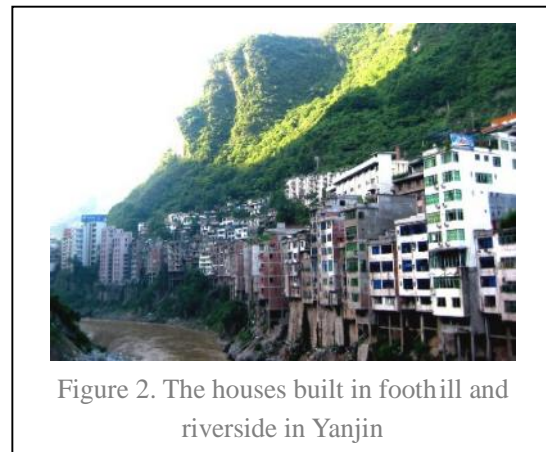


Figure 3. Partial collapse of residential house in Pu'er earthquake

On the basis of summarizing the recent earthquake damages to villages and towns, it is concluded that the phenomenon of “small earthquake caused heavy disaster” is rather serious and common in these regions. In recent years, hazardous earthquakes frequently occurred in China, especially in undeveloped central and western regions. However, due to the limitation of low levels of local economy, there are many problems existed in the construction of earthquake prevention and disaster mitigation in villages and towns. They consist of the following aspects: 1) Most of local buildings are not well designed for good anti-seismic ability. 2) Infrastructure construction is rather weak. 3) Capacity of social defense to earthquake is obviously inadequate. 4)



Educations of earthquake prevention and disaster mitigation are lag behind. 5) The villager's qualities of earthquake prevention and disaster mitigation are very poor. 6) Rural region's earthquake prevention and disaster mitigation system is extremely frail compared to that in urban area. Therefore, because of the problems mentioned above, the countryside regions always suffered severe damages when faced with destructive earthquake of M 5. Moreover, for the eastern regions with dense population and relatively developed economy, because little strong earthquakes occurred in the past years, people generally lack the consciousness of earthquake prevention and disaster mitigation, and the government also pays little attention to the investment and construction of earthquake prevention and disaster mitigation system. Thus, once the destructive earthquake occurs, it will result in great losses and influences beyond that of the expectation, while the Jiujiang earthquake (in Jiangxi province) occurred on 26 November 2005 has been a profound lesson.

3. GOAL AND PRESENT SITUATION

The overall goal of our country's earthquake prevention and disaster mitigation in 2020 is that the whole nation has the synthetic capability to combat earthquakes of about magnitude 6.0, which is equivalent to the basic seismic intensity of various areas. Whether can we smoothly realize the goals as mentioned above, the countryside regions are the key point, and simultaneously the difficult point. At present, the situation of earthquake prevention and disaster mitigation in China's villages and towns is not so optimistic, especially in rural regions, where the earthquakes are widely undefended and easily cause severe damages, which takes bad effects to the local economic development and the social sustainable development. In summary, although the construction of earthquake prevention and disaster mitigation capability in villages and towns have gotten some achievements recently, there is still a long way to go before we reach the preset goal as mentioned above, and there are still many problems need to be solved urgently, which mainly manifested in the following aspects.

3.1. Management System

The management system of earthquake prevention and disaster mitigation in villages and towns is imperfect. Recently, with the implementation of past several five-year plans, especially the 9th five-year and 10th five-year, the construction of earthquake prevention and disaster mitigation in China has made considerable progress. So far, the disaster reduction system of the large and medium cities has been nearly sound, while the management system associate with county-township-village three levels has not yet completed. What's more, in some countryside regions, there are no specific management organizations of earthquake prevention and disaster mitigation. However, as a system, the construction of earthquake prevention and disaster mitigation requires the widespread participation of social populace and the management of government departments. Although the active investment from social populace is essential in this work, it will be in vain without the united direction and coordinated management from government departments.

3.2. Structure Pattern

The structure patterns of residential houses in villages and towns are relatively outdated. At present, the timber-skeleton and brick-concrete structure still take a large proportion of the buildings in villages and towns of China, especially in undeveloped western areas, such as Yunnan, Gansu, Xinjiang, etc. The majority of local countryside houses still adopt the structure patterns of earth-timber and brick-timber. According to statistics from Chen J L [10], up to 2000, the brick-timber and mixed structure houses accounted for 87.39 percent of

occupied residential houses in villages and towns of China, while the ratio of earth-thatch roofed houses and other drawback buildings is 12.6%. For example, the major structure pattern of countryside houses on Taiyangshan’s two sides in Changde city of Hunan province is brick-timber, as shown in Table 1 [11]. Compared to reinforced concrete structures, anti-seismic performance of the earth-timber and brick-timber structure is rather weak, which can’t survive the destructive earthquake, as shown in Fig. 4.

Table 1. Statistics of building structure patterns in the two places / number of houses (rooms)

Structure pattern	Earth-stone wall	Timber - skeleton	Brick - timber	Brick - concrete	Reinforced concrete	Sum
Dalongzhan town	0	6(21)	46(255)	158(1731)	18(180)	228(2187)
Zhoujiaping village	14(49)	8(26)	239(953)	25(129)	1(6)	287(1163)



Figure 4. The house was destroyed in Pu’er earthquake

3.3. Construction Age

The construction age of residential houses in villages and towns are rather old. Since the late 1990s, our country has been in a period of the peak of construction in villages and towns. However, the houses built before 1990s still remain a large proportion of all the countryside buildings. Up to 2000, about 35 percent of countryside inhabitants didn’t construct new residential houses in the past 20 years [10]. The investigations to the buildings’ construction age of more than 90 villages in earthquake fortification zone with intensity 7 and above of Guangdong province are shown in Fig. 5 [12], from which we get the conclusion that the number of new houses constructed after 2000 is less than 1/5 of the total amount. While constructed in the early time, these old buildings in villages and towns are of low earthquake fortification level, which let them easily damaged under the action of the destructive earthquake.

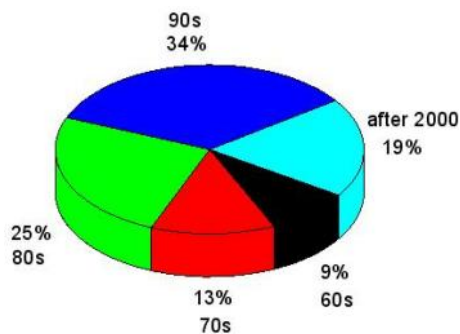


Figure 5. The ratio of countryside buildings with different construction ages

3.4. Seismic Technology

The seismic technology of construction in villages and towns is relatively low. In countryside regions, most of buildings are self-built houses, which generally constructed by the local artisans according to local traditions and customs, and in related with the financial conditions and requirements of house-owner. Without professional design, most of the self-built houses are constructed in irrational traditional method or lack scientific management in the construction stage, as shown in Fig. 6, which results in a low level of structure's anti-seismic capacity. What's more, some houses are even constructed without earthquake fortification at all.

Overall, there are many problems existed in aseismic capacity of countryside houses: 1) As constructed conveniently with simple plane arrangement, the houses are always not conducive to seismic in the pattern. 2) As constructed according to local conditions, the houses are of low cost with poor quality of building materials. 3) Villagers usually pay too much attention to the outward appearance, decoration and artistic style, while ignore reasonable structure pattern and earthquake resistant capability. 4) The houses which lack the overall construction plan and earthquake protective measures are common in villages and towns. 5) The seismic capacity of the houses is relatively low, with poor integral behavior of seismic structure and many weak links in earthquake resistance.



Figure 6. The earth wall with thickness of half meter

3.5. Disaster Education

The education of disaster control in villages and towns is still relatively backward. Since continuously, the local government has not conduct enough propaganda and education to earthquake disaster, which caused poor vigilance of the villagers when faced with earthquakes. Especially in rural regions, due to the lack of basic education of disaster control, these problems are even worse, as described in the following aspects: 1) Lacking the basic knowledge of earthquake disaster control, villagers are credulous to the earthquake rumor. 2) With the lack of the training of self-protection skills, the villagers' capability of self-save and mutual save is rather poor. 3) Villagers usually lack the initiative surveillance consciousness to government's earthquake disaster control work and pay insufficient attention to the security problems of their own inhabited area. 4) With weak awareness of disaster control, villagers can't be actively involved in earthquake prevention and disaster mitigation actions. 5) Because the disaster psychological bearing ability of villagers is poor, it is a common phenomenon that people are helpless and only wait for the rescue after earthquakes. What's more, some unnecessary casualties are incurred, because some populace are panic in the earthquake or take improper measures to avoid earthquake disaster.



4. COUNTERMEASURES AND SUGGESTIONS

Overall, the biggest bottleneck of disaster control construction in villages and towns of China probably lies in the relatively weak economic foundation. Limited by local economic conditions, the infrastructure construction of earthquake defense is too outdated and backward, thus there is a long way to go before we succeed in resisting the earthquake of magnitude 6. Therefore, the local government should pay more attention to the economic construction firstly, and promote harmonious development of society. Meanwhile, confronted with the troubles of disaster control in countryside regions, as mentioned above, the long-term plan needs to be completed and the following work needs to be done in the future :

- (a) The management function of the government should be enhanced, and the management system associate with county-township-village three levels should be completed. Firstly, under the instruction and support from the provincial and municipal government departments, the local institution construction of earthquake prevention and disaster mitigation are promoted, which organized by the county-level government. The union organizations of county-township-village three levels are being established, which play an important role in earthquake disaster control. Through its unified coordinate function, the specific tasks are allocated to various specialized agencies, thus the special mechanism of accountability is formed. Moreover, relying on this unified management system, the local government should pay more attention to construction supervision and management, and address potential security risks and earthquake disaster problems through special seismic audit and inspection of the local construction.
- (b) The plan of earthquake disaster reduction should be made in quick pace, and overall capability of earthquake disaster control in countryside regions should be enhanced. Based on the special opportunity that our country is vigorously advancing the socialism new rural reconstruction at present, the establishment and implementation of the plan should be well organized in the light of villages and towns' reality. It is imperative for us to complete the plan of earthquake disaster reduction, which mainly contains the long-term plan of improving the comprehensive capability of earthquake disaster control in countryside regions, the preparing plan before the earthquake, the emergency plan for short-term earthquake, and the post-earthquake recovery and reconstruction plan, etc. Only in this way, can we gradually sharpen the ability of mitigating earthquake disaster, effectively perfect the relevant technical standards, and basically establish the construction project quality guarantee system in villages and towns.
- (c) The aseismic technique research of countryside buildings should be strengthened, and then the level of earthquake disaster reduction can be raised through the scientific and technological progresses. Under the current situation, the country should fully display the effects of scientific research institutions and universities as brain-power, and promote the collaboration and conjunction of scientific research institutions, universities and enterprises. Meanwhile, the basic development and applied research of the earthquake science and technology should be emphasized and strengthened, and the construction of scientific research base and major research infrastructure should be enhanced, so as to provide the technological and intelligent support for earthquake disaster reduction construction, and enhance the innovation capacity of earthquake science and technology [9]. For countryside regions, the seismic performance of local houses should be further enhanced. Moreover, with the consideration of economy and security, the seismic fortification should be popularized and improved, while some practical and feasible new methods of earthquake disaster reduction should be proposed simultaneously, such as base isolation, energy dissipation, etc.
- (d) The propaganda and education of earthquake disaster control in countryside regions should be enhanced, and the disaster consciousness of local villagers should be improved. Unifying the establishment of earthquake disaster reduction plan, the local government departments should take the measures as following



- aspects: 1) The propaganda and education to the public should be widely carried on, by the means of boards, circulars, broadcasts, etc, so as to let the populace have a comprehensive understanding of earthquake principles, policies and countermeasures taken by authorities. 2) The annual earthquake security day (or security week and security month) should be set, and the local government should organize the masses of their jurisdiction to execute regular earthquake-proof exercise every year, so as to enhance social awareness of earthquake disaster reduction. 3) With the members selected from the villagers, the volunteer team of earthquake relief should be set up, and get formal professional training. 4) The new paths of disaster propaganda and education should be investigated, such as the school education model.
- (e) The disaster legislation should be enhanced, and the standard system of earthquake prevention and disaster mitigation should be established. The significance of disaster legislation lies in that it provides an official basis for disaster mitigation [13], which can regulate and coordinate the labor-division and cooperation of the relevant departments, thus to ensure that every order will be executed without fail and the responsibility will be taken in detail. At present, some earthquake laws and regulations are being gradually established and completed in China. Such as the Law of the People's Republic of China on Protecting Against and Mitigation Earthquake Disaster are being revised continuously, the standards of national and regional seismic zoning map are being compiled in time, the technical standard and design code of earthquake engineering fortification will be improved, etc [9]. On the basis of implementing national, provincial and municipal standard system of earthquake disaster reduction, some local earthquake standards and laws should be established in the light of reality, so as to guide and regulate the disaster reduction work.
- (f) The construction of contingent plans should be enhanced. At present, the construction status of China's earthquake emergency plans is, that the corresponding contingency plans for destructive earthquakes are relatively perfect in large or medium-sized cities, while the villages and towns where use the earthquake emergency plans of their administrative regions, rather than their own special plans. However, for such provincial and municipal contingent plans, they are not easy to go smoothly and always cannot balance the actual situation in countryside regions, because they need to cover wide areas and take account of the overall situation and many influencing factors. Therefore, the local government should organize related departments to make special earthquake emergency plans with the consideration of local realities in villages and towns, which also correspond largely with the earthquake emergency plans of their administrative regions. So it is expected, that the earthquake prevention and disaster mitigation work can be carried out smoothly and orderly in countryside regions under the guidance of some relevant contingent plans.

5. CONCLUSIONS

Earthquake prevention and disaster mitigation in villages and towns is an important mission, which will benefit the majority of people. Based on the present situation that the economic development of rural areas is relatively low, it is concluded that the construction of earthquake prevention and disaster mitigation in villages and towns will definitely be a long-term, arduous process. That is to say, it is not for one day or one night can we smoothly realize the goal that the entire national constructions achieve enough capacities to resist 6 magnitude of earthquake before 2020. Actually, to accomplish this target, we can not only depend on the government's work, what's more, but also need the entire society's joint effort and concerted cooperation. Only in this way, can we deal with the dialectical relations scientifically between the local economic development and the construction of earthquake prevention and disaster mitigation in villages and towns, and then lead the construction of villages and towns to a healthy path, along with a sustainable



development path. Thus, in this right way, the construction of earthquake prevention and disaster mitigation in villages and towns of China can get out of the plight .

REFERENCES

- [1] Chen Y, Chen Y T, Zhang G M, et al. (2005). Forecast and Early-warning and Preparedness Measures for Great Earthquake Disasters in China during the Period of the 11th Five -year Plan. *Journal of Catastrophology* **20:1**, 1~14.
- [2] Zhou Y, Zhang C, Guo Y H, et al. (2007). Review and Forecast of China's Earthquake Prevention and Disasters Reduction of in Recent Ten Years. *Journal of Disaster Prevention and Mitigation Engineering* **27:Suppl.**, 383~390.
- [3] China Association for Science and Technology, China Civil Engineering Society. (2007). Report on Advances in Civil Engineering in 2006-2007, China Science and Technology Press, Beijing, China
- [4] Wu C X, Tang T B, Nie Y H, et al. (2006). Build Damage Analysis of Jiujiang Earth quake in Jiangxi Province. *Earthquake Resistant Engineering and Retrofitting* **28:1**, 5~9.
- [5] Guo Y Z, Huang H M, Guo Y H, et al. (2006). Building Damage Analysis for the 2006 Yanjin Earthquake in Yunnan Province. *Technology for Earthquake Disaster Prevention* **1:4**, 353~358.
- [6] Zhang C, Wu C X, Wu S X, et al. (2008). Analysis on the Pu'er Ms 6.4 Earthquake Disaster in Yunnan Province. *Journal of Disaster Prevention and Mitigation Engineering* **28:2**, 230~235.
- [7] Wu S X, Wu C X, Han J J, et al. (2007). Investigation and Analysis of Brick and Concrete Building Damage Caused by Ning'er Ms 6.4 Earthquake in Yunnan Province. *Technology for Earthquake Disaster Prevention* **2:3**, 285~289.
- [8] Wu C X, Zhang C, Wu S X, et al. (2007). the Inspection Report of Pu'er Ms 6.4 Earthquake in Yunnan Province on June 3, 2007. The research center of public safety and disaster prevention and mitigation of Guangzhou University, Guangzhou, China
- [9] State Council office. (2007). National Earthquake Prevention and Disaster Mitigation Plan (2006 -2020). http://www.gov.cn/jrzq/2007-10/31/content_791708.htm
- [10] Chen J L. (2001). Investigation of the present situation in villages and towns of China. *Chinese and Foreign Red Estata Times* **:4**, 14~18.
- [11] Guo R, Yang Z X, Wang C, et al. (2001). Investigation into anti-Seismic capability of village and small town buildings around Taiyangshan in Changde city. *South China Journal of Seismology* **21:4**, 58~63.
- [12] Guo Y H, Zhou Y. (2005). Discussion on the Difficulties and the Countermeasures of Disasters Prevention and Mitigation in Impoverished Regions. *Earthquake Resistant Engineering* **27:Suppl.**, 191~195.
- [13] Gao Q H, Ma Z J. (1995). Talk again about System Engineering for Natural Disaster Reduction. *Journal of Natural Disasters* **4:2**, 6~13.